REMARKS

Amendments to the Claims

Claims 1-10 are under examination with entry of the present Amendment. Original claims 5 and 6 remain unchanged. Claim 2 has been cancelled without prejudice. Applicants reserve the right to pursue any unclaimed subject matter in one or more divisional or continuation applications. No amendment of inventorship is required.

Independent claim 1 has been amended to recite a seal for use in a high temperature fuel cell comprising: ceramic fibres providing a matrix for retaining ceramic powder and being capable of remaining flexible at operating temperatures of the fuel cell; ceramic powder being disposed within the matrix, a substantial proportion of the ceramic powder having a particle size of about 5 μm in diameter; the ceramic fibres and powder being capable of resisting sintering at operating temperatures of the fuel cell, wherein the seal is substantially free of binder and has a fired porosity between about 35% to about 60%. Support resides in the as-filed specification for example, in paragraphs [0025], [0028], [0035] and [0041].

The subject matter of claim 2 (now cancelled) has been incorporated into amended claim 1. Claims 3 and 7 have been amended to revise the claim dependencies. Claims 4 and 8-10 have been amended to correct inadvertent typographical errors.

No new matter has been added with the amendments made herein. Support for the amended claims is found throughout the application and in the as-filed claims. Applicants believe that the amended claims better define the invention in a manner supported by the original application, and in a manner so as to render moot the rejections as set out in greater detail below.

Rejections under 35 U.S.C. §102

The Office Action rejects claims 1-5 and 7-10 as being anticipated by U.S. Patent No. 5,098,871 to Ray. The Office Action states that:

> Ray teaches a ceramic composite with ceramic powders and fibres (col. 3, lines 18-35 and col. 5, lines 23-28) in which binder is removed and the porosity is increased by a binder

burnout phase. Specifically, Ray teaches in example one (col. 7, lines 20-52) that alumina is subjected to a binder burnout and then is sintered at 1080°C. However, this temperature is considered to be commensurate with the range taught by applicant in paragraph 29 of the specification, which reads "typically in the range of 500-1000°C." Applicant states that this range results in a composite that has been unsintered, therefore the article of Ray is not considered to be sintered in regard to Applicant's temperature teaching. Ray teaches that after heating to 1000°C, the density of the article is 60%, of the theoretical density which is considered to overlap (col. 7, lines 20-52). Since Applicant's claim 1 discloses alumina as the material and the reference also teaches alumina, and the method of heating is performed at a commensurate temperature, the characteristics would also be expected to be similar.

Applicants respectfully traverse this rejection. For greater clarity, Applicants have amended independent claim 1 to better define the specific structural features of the invention, and to include claim language which more clearly distinguishes from Ray. Ray describes a ceramic composite which is fully dense as indicated in the following passages (highlighting added for emphasis):

> One of the problems in forming ceramic matrix composites is obtaining a <u>highly densified</u> product. That is, whenever an organic binder is burned out of the ceramic matrix composite, porosity results. <u>Different approaches are used to fill the porosity to increase the density of the composite.</u> One approach is chemical vapor infiltration. However, during chemical vapor infiltration, material deposits on the surface of the composite, and holes or pores are closed, preventing further densification. Another approach is hot pressing which is expensive, and only simple shapes can be formed using this approach. Thus, it can be seen that there is a great need for a system which can substantially <u>eliminate the porosity</u>. The present invention solves this problem by providing a system wherein the formation of ceramic during sintering has a volume expansion which is effective in <u>reducing or eliminating porosity.</u> (column 2, lines 31-47)
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> . . .
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> The slurry is introduced to a web or webs of ceramic fibers to provide an infiltrated web. After removing liquid and organic binder from the infiltrated web, the green composite is sintered to react the aluminum oxide and boron oxide to form a ceramic matrix composite comprised of said web of ceramic fibers and aluminum borate. The reaction causes a volume expansion which <u>aids in filling or removal of pores or voids</u> resulting from the removal of organic binder. (column 2, lines 60-68 to column 3, lines 1-7).

Ray describes the composite as being 99% <u>dense</u> (column 3, lines 65-66). In contrast Applicants' flexible, <u>porous</u> seal has a fired porosity between about 35% to about 60%, as recited in Applicants' amended claim 1.

The Office Action refers to an intermediate phase (i.e., a porous material) in the formation of Ray's final composite. Applicants submit that Ray's intermediate product is not equivalent to Applicants' claimed seal. Although the intermediate product is formed of ceramic powder, Ray does not address relatively large particle size and the advantages of same. For example, in Ray's intermediate product, the aluminum oxide has "an average particle size of 0.4 μm in diameter" (column 3, line 47). In contrast, Applicants' amended claim 1 recites that a substantial proportion of the ceramic powder has a particle size of about 5 μm in diameter, a characteristic which contributes to the seal's flexibility. Neither Ray's intermediate nor final product is thus comparable to Applicants' claimed seal. Reconsideration and withdrawal of this rejection of claim 1 and dependent claims 3-5 and 7-10 are thus respectfully requested.

Rejections under 35 U.S.C. §103

The Office Action rejects claims 1-10 as being unpatentable over U.S. Patent No. 5,503,122 to Ritland and further in view of U.S. Patent No. 5,439,627 to De Jager. The Office Action states that:

> Ritland teaches a ceramic matrix with a powder ceramic that is presintered (or fired) to remove the binder, but is not sintered, with alumina as the ceramic, and the pre-sintered ceramic attains a porosity of 10-70%, which is considered to encompass a range of less than 50%, 45%, 40% and 35% porosity (col. 5, lines 30-40 and col. 7, lines 8-50). Ritland also suggest the use of ceramic fibres in metallic components (col. 3, lines 3-6). Ritland also teaches the use of a binder and the burning off of the binder to control porosity of the final product (col. 7, lines 7-27). However, Ritland does not specifically teach the use of ceramic fibres in the presintered ceramic matrix; however, De Jager teaches the manufacture of reinforced compositions using composites and laminates reinforced with long or continuous fibres or filaments with ceramic matrix composites (col. 1, lines 5-12), the use of binder which is removed by heating (col. 6, lines 11-14). De Jager also teaches that matrix particle (ceramic structure with fiber and filaments) present between the monofilaments keeps the filaments spaced, and the pre-form or molded structure becomes more and more porous during debinding (col. 6, lines 10-14 and lines 25-31). By this statement in De Jager, when the ceramic item containing binder is heated or fired, the binder will be removed, and with the binder being removed, the fibrous particles in the ceramic matrix will increase in porosity. Additionally, De Jager teaches the use of a tape casting process (col. 3, lines 3-7).
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> It would have been obvious to a person of ordinary skill in the art to combine that ceramic-metal engine component of Ritland with De Jager's methods of manufacturing reinforced

compositions with binders that increase porosity minimally to be able to design seals with lower porosity through combining metal powders with certain binders which can maximize physical strength and density.

Applicants respectfully traverse this rejection. Applicants submit that a proper obviousness rejection has not been made. *KSR International Co. v. Teleflex Inc., 550 U.S. __, 82 USPQ2d 1385 (2007)* articulated several guidelines for determining obviousness:

1) When a patent simply arranges old elements with each performing the same function it had been known to perform and yields no more than one would expect from such an arrangement, the combination is obvious.

2) A combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.

3) If a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.

4) When a work is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or a different one. If a person of ordinary skill can implement a predictable variation, §103 [obviousness] likely bars its patentability.

5) When there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp. If this leads to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense. In that instance that fact that a combination was obvious to try might show that it was obvious under §103.

6) When prior art teaches away from combining certain known elements, discovery of a successful means of combining them is more likely to be nonobvious.

7) To determine whether there was an apparent reason to combine the known elements in the way a patent claims, it will often be necessary to look to interrelated teachings of multiple patents (i.e., teaching or suggestion in the prior art); the effects of demands known to the design community or present in the marketplace; and background knowledge possessed by a person having ordinary skill in the art with ordinary creativity, insight, and common sense.

Applicants respectfully submit that a *prima facie* case for obviousness has not been made. Applicants' claimed invention does not constitute a predictable use of prior art elements according to their established functions. Applicants' claimed invention relates to a flexible, porous seal for use in a fuel cell operating in excess of 500°C and experiencing thermal cycling. Being flexible, the seal is capable of withstanding thermal expansion or contraction without degrading. The seal is formed of ceramic fibres which remain flexible, and ceramic powder of which the relatively large particle sizes contribute to the flexibility and compressibility of Applicants' seal. The seal is fired to remove substantially all of the binder used to combine the ceramic materials, thereby increasing the porosity from between about 25-50% to between about 35-60%. To Applicants' knowledge, those skilled in the art have generally avoided manufacturing seals in this manner due to the resultant increase in porosity. One skilled in the art having common sense at the time of the invention would not have reasonably considered or expected that a seal having a porosity of 35-60% would be operative in a high temperature fuel cell. Applicants' claimed invention constitutes more than a predictable variation of the prior art.

Applicants further submit that the prior art teaches away from combining the references as indicated by the Office Action. In *KSR*, the Court provided a detailed discussion of *United States v. Adams*, 383 U.S. 39 (1966), stating that "the Court relied upon the corollary principle that when the prior art teaches away from combining certain known elements, discovery of a successful means of combining them is more likely to be nonobvious." The Office Action has combined the teachings of Ritland with those of De Jager. Applicants submit that Ritland teaches ceramic-metal composites which are "substantially dense and non-porous" (column 3, lines 23-27). The composites are fabricated by infiltrating a metal into a porous ceramic matrix which serves simply as an intermediate phase in the formation of the final ceramic-metal composites. The Office Action states that at the intermediate phase, "the process can be stopped and the article is tangible and permanent in its intermediate state, thereby <u>teaching the same article as the claimed invention</u> of the applicant." Applicants respectfully disagree. Ritland's intermediate product is formed of ceramic powder, but lacks Applicants' ceramic fibres which provide a matrix for retaining the ceramic powder and impart flexibility to the resultant seal. Paragraph [0030] of Applicants' as-filed specification explicitly

states that "it is the combination of the particles within the fibre matrix which provides adequate sealing performance."

Further, particle size of the ceramic powder is not critical in Ritland which states that

> In the vapor phase sintering process, a green body is formed from ceramic powder. The starting particle size is not critical to the practice of the present invention, however, a smaller average particle size can be used to produce a sintered body having a lower average pore size. (column 6, lines 28-32)

Ritland's Example 1 describes use of a powder with an average particle size of about 1 μm. Ritland thus teaches away from relatively large particle size. In contrast, Applicants found that maintaining relatively large particle sizes in the ceramic powder provides good compressibility, flexibility and high powder loading density, with a substantial proportion of the ceramic powder having a particle size of about 5 μm in diameter, as recited in Applicants' amended claims. In one embodiment, for example, 60% of the particles are about 5 μm in diameter and the remainder may be about 1 μm in diameter (paragraph [0035] of the as-filed specification). Ritland's intermediate product is clearly not the same as Applicants' claimed seal in lacking the ceramic fibres and relatively large particle size of the ceramic powder, as recited in Applicants' amended claims. Thus, the language of Applicants' claims distinguishes the teachings of Ritland.

The Office Action turns to De Jager for teachings of ceramic fibres in the presintered ceramic matrix. There is no reason why one skilled in the art having common sense would have combined the prior art elements in the manner claimed, since the additional cited reference does nothing to overcome the deficiencies of Ritland. Applicants submit that De Jager relates to composites and laminates reinforced with "long or continuous fibres and/or filaments in a unidirectional configuration or with long chopped fibres or filaments in a chopped-aligned configuration" (column 2, lines 50-54). Spacer particles are used "to separate the fibres or filaments uniformly over a certain distance and maintain the general longitudinal orientation of the fibres or filaments" (column 5, lines 42-44). The fibres or filaments "are high strength, high stiffness, low density fibres" (column 5,

lines 1-3). The choice of stiff fibres and the arrangement of fibres and particles results in a product which is stiff for use in high performance applications

> such as in aerospace, automobile, chemical and petrochemical, fusion or plasma reactors, grinding tools, defence and other, where continuous and long fiber reinforced composites, like carbon, carbon/ceramic, ceramic, glass, glass/ceramic, metal, intermetallic and others are and will be required. Especially aerospace applications need stiff very high performance materials, e.g. for air-breathing propulsion systems, such as gas turbine components, heat-shields, rocket nozzles, ramjet combustors and both primary structures and airframes for reusable aerospace (hypersonic) vehicles and satellites, that can be fabricated into complex shapes. Special features can be built in e.g. electrical conductivity/discontinuity/ heating, magnetic, shape memory, thermal conductivity (column 9, lines 4-22, highlighting added for emphasis).

For such applications, De Jagers' stiff composites and laminates are "dense composite materials" (column 3, lines 9 and 55-57), since voids and cavities arising during their manufacture are filled with matrix material as further described below:

> The void spaces between the mono-filaments and the particles are then filled up/reinfiltrated by any of the usual preform reinfiltration methods or combinations thereof, e.g. by gravity, continuous, inert gas pressure or vacuum infiltration with a matrix material (in liquid/melt or slurry form) by chemical vapour infiltration (CVI), by chemical/diffusion or reaction bonding, or by forming a matrix material in situ by reaction at relative low temperatures between infiltrated liquid or solid/slurry materials and appropriate gases (e.g. directed metal oxidation). (column 8, lines 35-45)

De Jager thus teaches away from a flexible, porous seal. In contrast to De Jager's stiff, dense composites and laminates, Applicants' claimed invention relates to a flexible, porous seal for use in a fuel cell operating in excess of 500°C and experiencing thermal cycling. The flexible seal is "plastically deformable" since it is compressed between interconnects and a fuel cell (paragraph [0008] and Figure 1 of the as-filed specification), and may flex or experience thermal expansion or contraction without degrading (paragraph [0028] of the as-filed specification). The fibres of the seal remain flexible at the cell's operating temperature (paragraph [0025] of the as-filed specification). Further, the large particle sizes in the ceramic powder contribute to the flexibility and

compressibility of Applicants' seal (paragraph [0035] of the as-filed specification). However, nowhere does De Jager address a flexible seal, flexible ceramic fibres, particle size, the capability of a flexible seal to withstand thermal expansion or contraction without degradation, or a porosity between about 35-60% as recited in Applicants' amended claims. Thus, the language of Applicants' claims distinguishes the teachings of De Jager.

A patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art (*KSR*). The Office Action's combination of Ritland and De Jager is considered improper. The basis of this combination is that Ritland's intermediate product can be combined with De Jager's ceramic fibres, which would potentially result in a substantially rigid or non-flexible product due to inclusion of De Jager's stiff, dense fibres. For the reasons set out above, Applicants submit that a combination of Ritland and De Jager would not equate to the claimed invention due to fundamental differences between the prior art composites and Applicants' invention, and to claim features not found in either Ritland or De Jager. A combination of Ritland and De Jager does not teach a product which is capable of performing in the same capacity as Applicants' claimed invention. Reconsideration and withdrawal of this rejection of claim 1 and dependent claims 3-10 are thus respectfully requested.

Applicants submit that it is improper to reject any of these claims under 35 U.S.C. §103. Applicants have established that the claimed invention is not a predictable use of prior art elements. The prior art teach away from Applicants' claimed invention, indicating that there is no reason for one skilled in the art having common sense to make the asserted combination. Even if combined, the prior art does not yield Applicants' claimed invention or disclose each limitation in Applicants' claims. A *prime facie* case of obviousness has not been established. In summary, claims 1 and 3-10 are not anticipated or rendered obvious in view of the cited prior art. Reconsideration and withdrawal of all claim rejections under 35 U.S.C. §102 and §103 are thus respectfully requested.

CONCLUSION

In view of the foregoing remarks and amendments, it is respectfully submitted that this application is in condition for allowance and allowance thereof is respectfully requested.

If there are any outstanding issues related to patentability, the courtesy of a telephone interview is requested and the Examiner is invited to call to arrange a mutually convenient time.

Respectfully submitted,

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By: ______________________

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